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of

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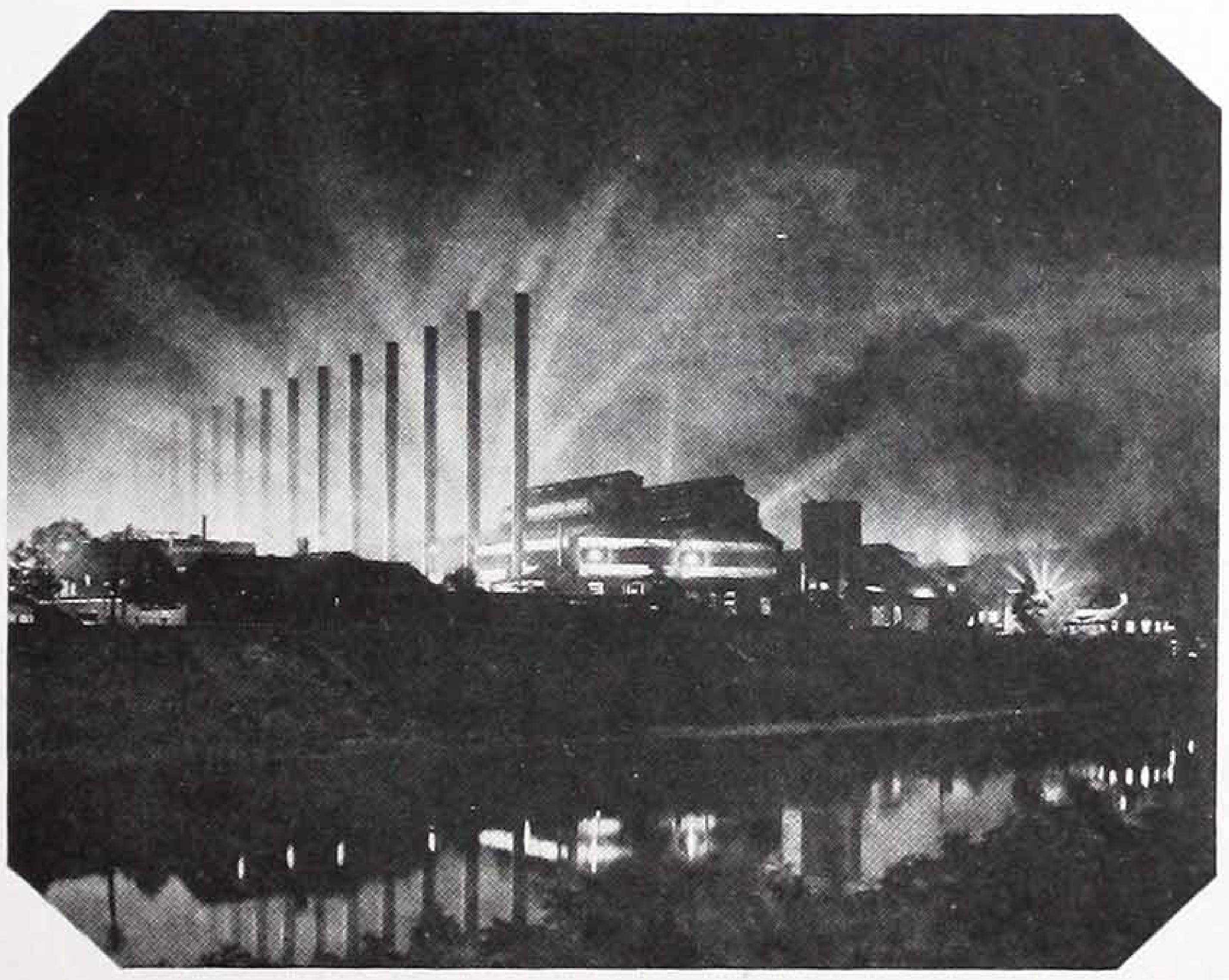

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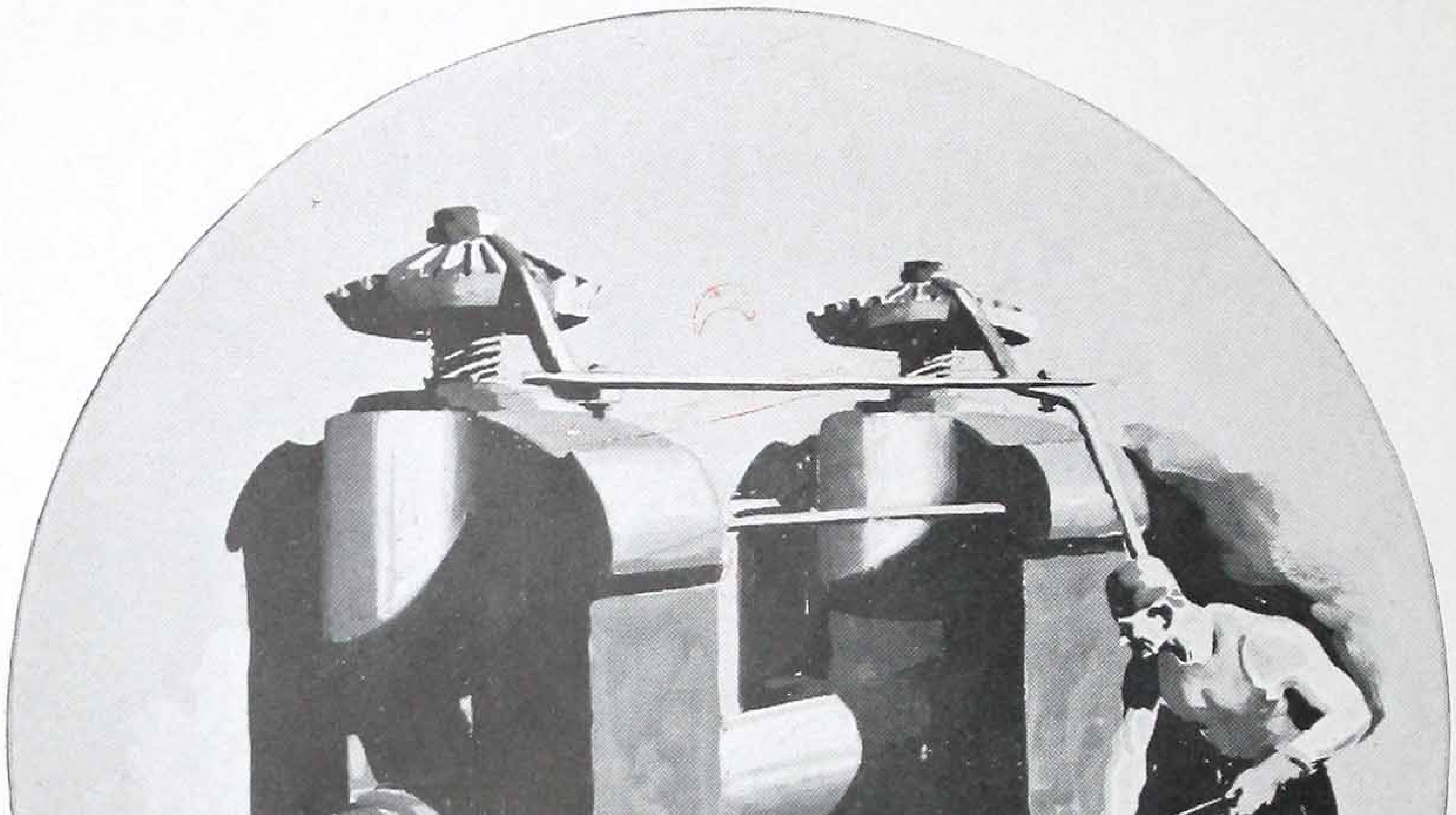

The Protection of Iron and Steel Sheets Against Rusting

Abridged from article
written in non-technical terms by the late Robert Skemp, *Assistant to Vice President,*
American Sheet and Tin Plate Company

THE great arch enemy of iron and steel is *rust*. It is impossible to even compute the constant and enormous losses for which it is responsible. As a matter of fact, iron ore itself is primarily a natural iron rust, combined to a greater or less extent with rock, earth, or other substances; and while it is refined into products that contribute greatly to human progress, yet this destructive enemy, corrosion, is ever alert to bring such products back to their original state of natural rust, or iron ore.

Endless efforts have been made to find the solution for this age old problem, but it has never been fully solved. Many claims of *rust proof* have proved quite pretentious and extravagant. However, iron and steel can be made to *resist* rust, and through manufacturing operations or alloying, prove decidedly rust-retarding, or slow rusting. Rust can also be prevented for greater or less length of time by the use of various protective coatings. Such coatings are effective only so long as they endure; but when they ultimately fail, rust will immediately attack the unprotected metal. It is nature's unalterable law.

The problem is interesting, particularly in view of the extensive development of the iron and steel industry. We shall not here digress into an extended metallurgical discussion of rust or corrosion, its cause, its processes, and progression, which are, of necessity, involved in the deductions and technicalities of scientific research, and present problems and theories with frequent divergent and conflicting conclusions. We shall, however, confine ourselves to the consideration of some means of protection of those forms of iron and steel which are of particular interest to the reader—Sheets and Plates.

The art of the iron and steel worker is an ancient one. Through effort and the use of well known mechanical and chemical means, man has succeeded in separating iron from its natural affinities, and

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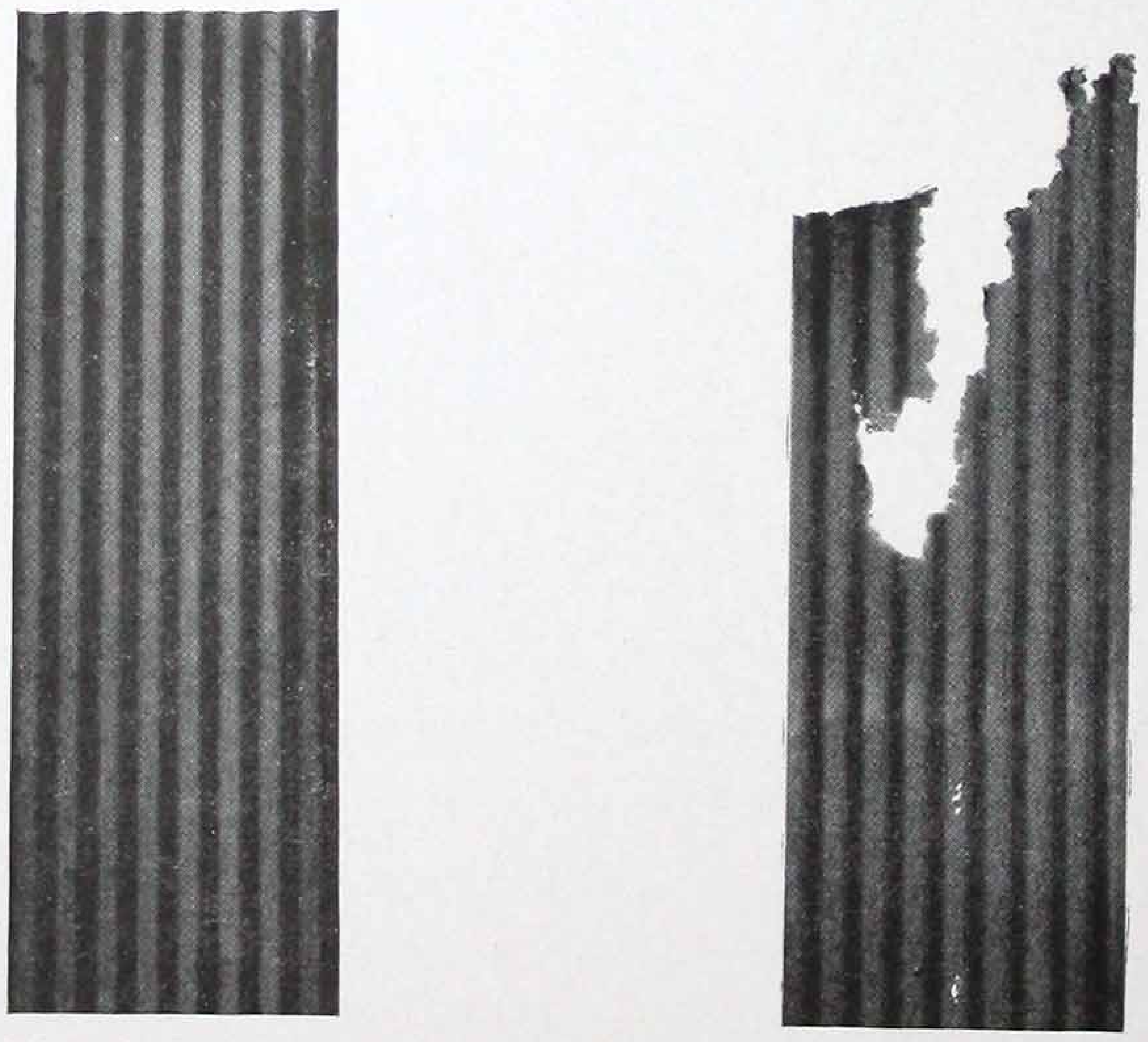
in forming it into a multitude of serviceable products, so familiar to us all. Nature yields for the time to the force applied, but, as before stated, immediately starts with unfailing natural processes to regain that which has been wrung from her.

At the first favorable opportunity when exposed to the elements, iron and oxygen will unite, forming rust, which is similar in its composition to native lake ores. It is rather a gruesome parody, but it may truly be said of *all* iron and steel, "Rust thou wert, and unto rust shalt thou return." It is all a question of *time*. In the uneven conflict, man strives for delay, and by the methods we have suggested, has accomplished much in his efforts to retard or prevent the ultimate destruction of iron and steel by action of corrosion or rust. We shall consider some of these methods briefly.

ALLOYING FOR RUST-RESISTANCE

In studying the effects of alloying other metals with steel, a very important help in this problem has been developed in combating rust. Science has demonstrated that very valuable and specific qualities or advantages have followed the use of certain alloys. It has



Alloyed with Copper

No Copper—Note Loss

One of many actual service tests which demonstrate the value of a copper alloy. These two sheets were exposed side by side for the same length of time. They were identical in manufacture—the same gauge, and from the same heat—the only difference being the *alloy of copper*. Time and weather did the rest!

been found that a proper percentage of copper added to the steel while it is in a molten state, adds greatly to the ability of the products made from it to resist corrosion, which is the word commonly used to express active rusting. This discovery has particular value when advantage is taken of it in the manufacture of iron and steel products that are to be exposed to weather conditions. Well informed users of sheet metals are quite familiar with the increased service and endurance that is secured from Copper-Steel.

PROTECTIVE COATINGS FOR SHEETS AND PLATES

Galvanizing

Other highly important factors in the fight against rust are protective coatings. There are numerous coatings employed for this purpose, but reference is here made only to those which carry particular interest to buyers and users of sheets and plates.

The greatest amount of protection against corrosion is afforded by a coating of zinc, where the conditions permit of its use. The process of coating with zinc, or zincing, is commonly known as galvanizing. When sheets and plates, or other forms of iron and steel, are to be galvanized, they are first pickled in a bath of hot dilute sulphuric acid. The pickling is done for the purpose of removing the skin of iron oxide, or scale, which has formed on the surface of the iron or steel products during the processes of heating and rolling. Unless this oxide is all removed, and the metallic surface made quite clean, the galvanizing cannot be done successfully.

After pickling, the sheets or plates are immersed in fresh cold water for the purpose of washing away the iron salts resulting from this operation. From the wash tanks in the pickle house, the articles to be coated are conveyed to the galvanizing shop. The galvanizing pots are usually square or oblong tanks of steel which are encased in brick settings, the settings being provided with the necessary fire-box, and with flues to carry the heat around the pot and to convey the waste gas to the stacks. The pots vary in size, and usually contain a bath of forty to sixty tons of molten zinc.

For galvanizing sheets and light plates, power driven machines consisting of properly arranged rolls and guides are immersed in the molten zinc within the pots. Before being fed into the rolls of the machine for conveyance through the bath of zinc, the sheets or plates are passed through a solution of muriatic acid to free them from such slight surface rust as may have formed between the operations of pickling and galvanizing.

At the intake end of the pot, is a box consisting of four walls of steel plates which extend downward for a short distance into the molten zinc. The zinc thus becomes the bottom of the box. The space in the box above the zinc is filled with sal ammoniac, which is melted by the heat of the zinc and acts as a flux.

The sheet or plate after being passed through the tank containing the muriatic acid solution, is driven by the rolls of the machine down through the flux into and through the bath of molten zinc. Steel guides keep the sheet in place between the sets of rolls, and it finally comes up through the exit rolls, which are half submerged in the zinc. The opening between these rolls affords an outlet for the sheets, through molten zinc which is at this point free from surface impurities. From these rolls the sheet travels on a chain conveyor to the inspection table and cooling-rack.

The coating of zinc on the sheets as they emerge from the pot has a bright uniform lustre, which changes as the zinc cools into the crystalline frosted or spangled appearance, which is characteristic of all galvanized products. It is important to remember, however, that the size and brilliance of the spangles on galvanized sheets, while pleasing and attractive, are not nearly so vital or important as is the fact that a properly applied and well amalgamated coating has been effected on the surface to be protected.

As before stated, zinc is one of the most effective agents in protecting iron and steel from rust. It must be remembered, however, that the zinc coating which alloys itself with the steel *is not so pliable* and ductile as the steel base, and does *not* lend itself naturally to severe forming or drawing operations. Heavy coatings of zinc are, from their very nature, liable to crack and peel off under such severe strains, and while desirable for *flat uses* or where the forming strains are light, are not calculated to give best service under difficult forming conditions, or when any draw is involved. This important fact must always be borne in mind by users of galvanized sheet products. In the desire to obtain the best anti-corrosion results, engineers sometimes overlook these characteristics of brittleness in heavy coatings, and frequently write specifications for manufacturers which are more or less impracticable.

The original method of galvanizing was to dip the sheets, plates, or other articles to be coated, in a suitable pot containing molten zinc. This method is still followed for galvanizing rigid products or articles which are formed from black sheets, and on which a heavy coating is desired.

In addition to the quantities of galvanized sheets used for culverts, tanks, flumes, and a host of other uses, many thousands of tons of these sheets are used for covering the roofs and sides of buildings. When so used, the sheets are usually corrugated. The corrugations are made by passing the sheets sidewise through long, fluted iron rolls, which are driven by belt or motor power. The purpose of corrugating the sheets is to make them strong and stiff, capable of standing up against high wind pressure, and of bearing up and supporting the weight of heavy snow falls. These galvanized corrugated sheets are largely used for covering roofs and sides of steel works, rolling mills, foundries, and other industrial buildings of a similar nature.

Terne Coating

Another method of protecting steel sheets against rust is by coating them with an alloy of tin and lead. Steel sheets when thus coated are called Terne Plates, or Roofing Tin Plates, and the so-called tin roof is in reality a terne plate roof.

This form of roofing, because of the ease with which it can be soldered and seamed, is especially desirable for buildings with flat or low pitched roofs, and is particularly adapted to the roofing of public buildings, residences, and for porches, valleys, flashings, etc.

After having been rolled in the usual manner, the steel sheets, which constitute the base of terne plate, are pickled to remove surface oxide, annealed to make them soft and pliable, cold rolled to make them flat, again annealed, and again pickled. The sheets when thus prepared are coated by passing them through a molten bath of the alloy of tin and lead. Various weights of coating are manufactured—the first coating being a light coat, and the second coating, which is obtained by re-dipping, being a heavy coat. Modifications of the weight of coating on a re-dipped plate are obtained by dipping the plate, while the coat is still molten, in hot palm oil.

For some grades, machinery consisting of driven rolls and guides is used in conveying the steel plate through the bath of molten metal. For other grades, no machinery is used, but the steel plate is dipped and re-dipped both in metal and oil entirely by hand. For still other grades, a combination of machine coating and re-dipping by hand is used.

For all grades, the utilization of a base of steel alloyed with copper, or Copper Steel, as it is now generally called, adds greatly to the life of a Terne plate roof. The weight of coating which varies from eight pounds per case to forty pounds per case is also a material factor in the life of a roof. What is known as "a case" or box of Terne plate consists of 112 sheets, 20x28 inches in size.

Bright Tin Plates differ from terne plates in that the coating employed is pure block tin, and that such plates are manufactured principally for utensils, cans and containers. The coatings and particular uses of Bright Tin Plate will not be discussed in this paper.

For all construction purposes, however, the maximum of resistance to weather corrosion in secured by the use of a copper-steel sheet, coated either with zinc or with the alloy of tin and lead, and finally painted on both sides with a suitable paint.

Painting Sheet Metals

As all ferrous metals, and likewise the more precious metals, gradually corrode, therefore all ordinary sheet metal exposed to the elements should be given a protective coating . Even the zinc coating of galvanized sheets is gradually weathered away, and the application of a good paint, renewed at proper intervals according to climatic conditions, will prolong the useful life of sheets almost indefinitely.

All sheets should be clean, so as to obtain close contact of paint and metal. Uncoated (black) sheets should be free from loose mill oxide and rust, and, if necessary, wire brushed and wiped with turpentine or gasoline. Grease and oil may be washed off with a suitable solvent, such as naphtha or toluol. Terne coated(roofing tin) is best wiped with benzine, turpentine, or benzol to remove the oil film. Zinc coated (galvanized) is best prepared by simple exposure to the weather for a few months until the luster disappears. If necessary to apply paint to new zinc coated sheets, they should first be brushed with a solution of four ounces of copper sulphate, copper chloride, or copper acetate in one gallon of water, and after drying again brushed lightly. Better results may be obtained, if facilities permit,by cleaning with a solution of 200 parts of water, 30 parts trisodium phosphate, and 4 parts of sodium hydroxide, all by weight, at 140 to 180° F., then washing with hot water, followed by etching at room temperature for about one-half minute with solution of 1000 parts water, 200 parts muriatic acid, and 20 parts ammonium nitrate, all by weight, and then washing and thoroughly drying.

The weather should be clear and dry and the paint preferably applied in the afternoon, especially the priming coat, as it is essential that the surface be free from moisture. It is preferable to coat the surfaces in laps with fairly thick priming paint as the sheets are placed in position. The paint may be applied by brush or spray. The priming coat should be thin enough to fill and wet all parts as too thick a paint is liable to bridge over depressions and joints. The finish coat or coats should be thicker, and a total of not less than two coats should be applied, giving time for proper drying between coats.

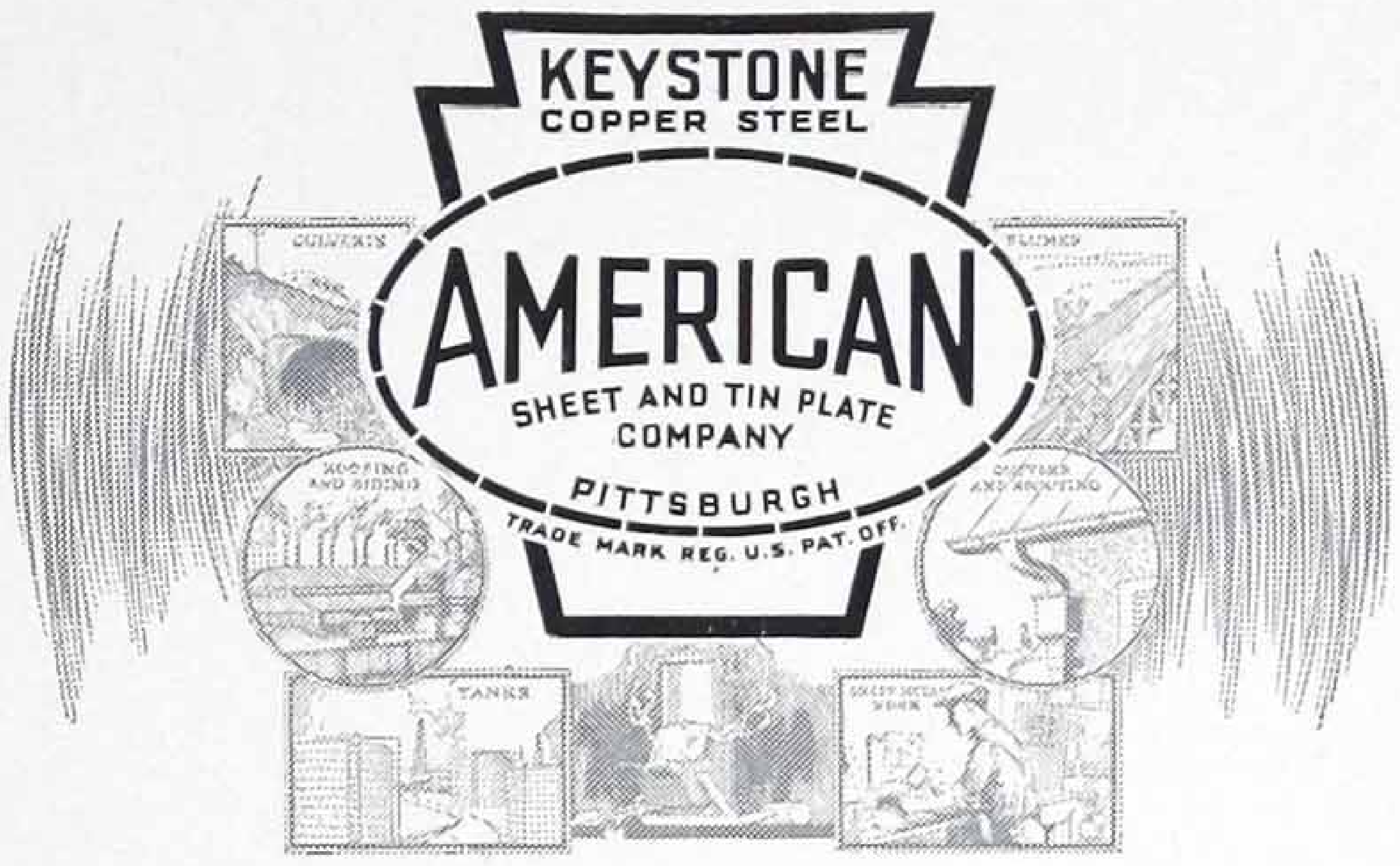
Paint applied directly to sheet metal should be rust inhibitive, and the priming coat should, therefore, have a basic pigment, such as red lead, lead chromate, or zinc chromate — zinc dust and zinc oxide three or four to one, make efficient paint for both priming and finishing, especially as primer for zinc coated (galvanized) sheets. Iron oxide paint is used for priming and has given good service, but much better protection is obtained if it contain 10 per cent or more of basic or chromate pigment, such as zinc oxide, redlead, or zinc chromate. The pigment for the finish may be of any good moisture excluder of suitable color. Linseed oil, preferably boiled, makes a good vehicle for the pigment, and excessive dryer should not be used. The use of boiled linseed oil or durable mixing varnish as part of the last coat adds to gloss and water resistance. It is economy to use only the best grades of paint for metal work.

More extensive information may be gained from "Paints for Metal," issued by the Institute of Paint and Varnish Research, Washington, D. C.

The whole subject of painting sheet metal work is one of great importance, and merits careful and informed attention. Generally speaking, it is always strictest economy to employ good paints that are specially adapted to the work in hand, with capable craftsmanship which will insure a proper application. Good results invariably follow.

KEYSTONE COPPER STEEL

The Superior Anti-Corrosive Sheet Metal



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Practical experience and scientific tests prove the excellence and durability of KEYSTONE COPPER STEEL for Black and Galvanized Sheets and Terne Plates. The copper alloy base under a good protective coating will give maximum service and satisfaction. It is the safe, practical and economical material to use—

For Roofing and Siding
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